IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of   Atty. Docket: NL 021105

ROY HENDRIK ANNA MARIA VAN ZUNDERT ET AL.

International Application No. PCT/IB03/050015

Serial No. 10/534,318

Confirmation No. 4916
Group Art Unit:

Filed: MAY 9, 2005   Examiner:

Title: CIRCUIT ARRANGEMENT

Mail Stop Petition
Commissioner for Patents
Office of PCT Legal Administration
P.O. Box 1450
Alexandria, VA 22313-1450

Petition Under 37 CFR §1.182

Sir:

Applicants hereby petition:

-        to delete incorrect papers from the file wrapper

         referring to the following incorrect International

         Application No. PCT/IB03/05015, including the

         specification, claims and abstract entitled Magnetic

         Resonance Imaging System, and substitute therefor the

         enclosed correct specification, claims and abstract of

the present application entitled CIRCUIT, which is International Application No. PCT/IB03/050015, published as WO 2004/045255 (Exhibit A);

- to issue a corrected Filing Receipt and a Notice of Acceptance of Application under 35 U.S.C 371 and 37 CFR 1.495; and

- to obtain from the International Bureau (IB) a certified copy of Foreign Priority Application, namely, EP 02079686.8, filed on November 11, 2002, as claimed under 35 USC 119 in the executed Declaration of file, which refers to the correct incorrect International Application No. PCT/IB03/050015 (published as WO 2004/045255.

On May 9, 2005, the national stage in the U.S. was entered under 35 U.S.C 371 where, in the Transmittal Letter Form PTO-1390 (Exhibit B), the International Application No. was incorrectly referred to as PCT/IB03/05015, which is

missing a digit. It appears that the Patent Office incorrectly added a zero at the beginning of the incorrect No. 05015 to result in No. PCT/IB03/005015, published as WO 2004/053514, and entitled "Magnetic Resonance Imaging System with a Plurality of Transmit Coils." The file wrapper of the present application includes this incorrect application and associated certified copy of Foreign Priority Application, namely, EP 02080152.8.

There is plenty of evidence on record that the intended correct International Application No. is PCT/IB03/050015 (and not PCT/IB03/05015), such as recited in the executed Declaration (Exhibit C); and recited in the assignment executed by Roy Hendrik Anna Maria Van Zundert to Koninklijke Philips Electronics, N.V., recorded on Reel/Frame Nos. 017357/0653 (copies enclosed as Exhibits D and E).

Further, a Preliminary Amendment (Exhibit F) filed concurrently with the Transmittal Letter Form PTO-1390 on May 9, 2005, amends the correct set of claims associated with International Application No. PCT/IB03/050015 (published as WO 2004/045255), which claims are different from those in
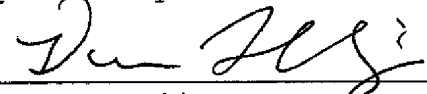
International Application No. PCT/IB03/005015 (published as WO

2004/053514, and a copy enclosed as Exhibit G).

Accordingly, it is apparent that the intended application

is International Application No. is PCT/IB03/050015 (and not

PCT/IB03/05015).

The petition fee of $400 is enclosed.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statement and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

By _____
Dicran Halajian, Reg. 39,703
Attorney for Applicant(s)
January 22, 2008

Enclosures: Exhibit A - WO 2004/045255
              Exhibit B - Form PTO-1390
              Exhibit C - Executed Declaration
              Exhibit D - Assignment Executed by Roy Van Zundert
              Exhibit E - Notice of Recordation of Assignment
              Exhibit F - Preliminary Amendment
              Exhibit G - WO 2004/053514

THORNE & HALAJIAN, LLP
Applied Technology Center
111 West Main Street
Bay Shore, NY 11706
Tel: (631) 665-5139
Fax: (631) 665-5101

Exhibit A

(54) Title: CIRCUIT ARRANGEMENT

(57) Abstract: A circuit arrangement for operating a high pressure discharge lamp comprises a down converter equipped with an output capacitor and a commutator equipped with lamp connection terminals. The amplitude of the DC current generated by the down converter is controlled by means of a control loop. Commutation of the DC current causes a periodical voltage to be present across the output capacitor. This periodical voltage can be an overshoot voltage and/or a voltage caused by resonance of the lamp with the output capacitor. To suppress the periodical voltage, the reference signal of the current control loop is adjusted in dependency of the amplitude of the periodical voltage.

CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW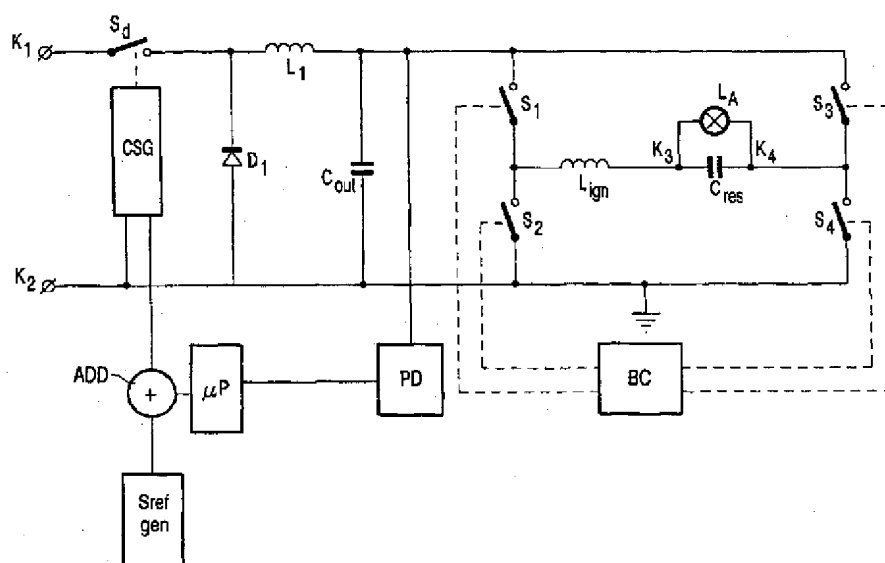, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT,

LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

1

Circuit arrangement

The invention relates to a circuit arrangement for operating a high pressure
discharge lamp comprising
- input terminals for connection to a supply voltage source,
- a DC-DC-converter coupled to the input terminals for generating a DC current out of a
5   supply voltage supplied by the supply voltage source and comprising
- a control loop for controlling the DC current at a value that is represented by a reference
  signal Sref,
- a control circuit for adjusting the reference signal Sref, and
- an output capacitor,
10 - a commutator for commutating the DC current and comprising lamp connection
  terminals.

Such a circuit arrangement is known and is for instance often used to operate
15   ultra high pressure lamps in projection equipment. In practice the commutator often
comprises a full bridge circuit and the frequency of commutation often is in the order of
magnitude of 10 Hz or 100 Hz. Between two subsequent commutations the DC current is
controlled at a constant value represented by the reference value Sref for most of the time. As
a consequence the current through the high pressure discharge lamp is a low frequency
20   substantially square wave shaped AC current. It has been found that the high pressure
discharge lamp can be operated in a stable and efficient way by means of such a current.
Several problems are associated with the commutation of the DC current. For a short time
lapse during the commutation all the switching elements comprised in the bridge circuit are
non-conductive, so that no current is supplied to the bridge circuit by the DC-DC-converter.
25   As a consequence the voltage across the output capacitor increases during this short time
lapse. This increase in voltage across the output capacitor causes an increase in lamp current
directly after the commutation. This increase in lamp current is undesirable since it causes the
lamp to temporarily generate more light so that the light output is not substantially constant.

2

In practice this temporary increase in the voltage across the capacitor, commonly referred to as "overshoot", is often counteracted by temporarily decreasing the value of Sref in the direct vicinity of a commutation. The decrease in Sref, often referred to as "dip", causes the DC-current to temporarily have a comparatively low value during a small

5   time lapse. As a result the overshoot caused by the commutation is suppressed to a large extent. The dip can be considered as a modulation of the reference signal Sref that is taking place with the same frequency as the commutation of the DC-current. The "dip" is characterized by dip parameters such as ΔSref (the depth of the dip), the time lapse during which Sref is maintained at the decreased level, the rate at which Sref is decreased at the

10   beginning of the dip, the rate at which Sref is increased at the the end of the dip and the phase relation between the modulated signal Sref and the the lamp current. It has been found that different types of high pressure lamps require a different setting of the dip parameters in order to obtain a maximal suppression of the overshoot. Similarly, it has also been found that high pressure discharge lamps of the same type but with a different "age" (= number of hours

15   that the lamp has burned), require a different setting of the dip parameters for an optimal suppression of the overshoot. As a consequence the overshoot suppression implemented in the known circuit arrangements is only optimized for one particular lamp type and even only for one particular age of that lamp.

       Another problem associated with the commutation of the DC current is that it

20   effects a substantially stepwise change in the load of the circuit arrangement. This stepwise change in the load of the circuit arrangement causes the down converter output capacitor to resonate with components included in the commutator such as an ignition choke and/or with the lamp. Consequently an AC-current of compatively high frequency is superimposed on the lamp current and an AC voltage of identical frequency is superimposed on the voltage across

25   the output capacitor. This resonance in turn often causes audible noise and influences the light output of the lamp. Furthermore this resonance can damage the lamp.

       The invention aims to provide a circuit arrangement for operating a high

30   pressure discharge lamp in which the problems associated with the commutation of the DC-current are effectively counteracted for many different types of high pressure discharge lamps during their complete life time.

       A circuit arrangement as mentioned in the opening paragraph is therefore according to the invention characterized in that the control circuit comprises means for

3

adjusting the reference signal Sref in dependency of the amplitude of a periodical voltage that is present across the output capacitor and is caused by the commutation of the DC current.

In a circuit arrangement according to the invention the signal Sref is adjusted
5   in dependency of the amplitude of the periodical voltage that is present across the output capacitor and is caused by the commutation of the DC-current. This periodical voltage can be the overshoot voltage but can also be the an AC voltage caused by resonance between the output capacitor of the DC-DC-converter on the one hand and (a) component(s) of the commutator and/or the high pressure discharge lamp on the other hand. The adjustment of
10   Sref in dependency of the periodical voltage present across the output capacitor results in an effective suppression of these periodical voltages. It has been found that in a circuit arrangement according to the invention the periodic voltage across the output capacitor is effectively suppressed for many different types of high pressure discharge lamps. It has also been found that this effective suppression was maintained during the whole life time of the
15   lamp.

In a first preferred embodiment of a circuit arrangement according to the invention, the control circuit comprises circuitry for generating a signal Scorr that represents the momentary amplitude of the AC voltage across the output capacitor and circuitry for subtracting the signal Scorr from the reference signal Sref. The control circuit in this first
20   preferred embodiment is comparatively simple and can also be implemented in a comparatively simple way. The circuitry for generating the signal Scorr may comprise a filter that passes a frequency band around the frequency of the resonance.

Good results have been obtained for embodiments of a circuit arrangement according to the invention, wherein the signal Scorr is proportional to the momentary
25   amplitude of the AC voltage across the output capacitor. When a high pressure discharge lamp ages, its impedance changes. It has been found that a very effective suppression of the AC voltage is obtained, in case the circuit arrangement is equipped with circuitry for adjusting the ratio between the signal Scorr and the amplitude of the AC voltage across the output capacitor in dependency of the age of the lamp. More in particular the ratio between
30   the signal Scorr and the momentary amplitude of the AC voltage across the output capacitor is decreased when the lamp ages. To this end the circuit arrangement could comprise a timer for measuring the number of hours during which the lamp burns and means for adjusting the ratio between the signal Scorr and the amplitude of the AC voltage in dependency of this number of hours. It has been found, however, that a very simple and effective

4

implementation can be realized by adjusting the ratio between the signal Scorr and the
momentary amplitude of the AC voltage in dependency of the lamp voltage, since the lamp
voltage increases when the lamp ages.

In a second preferred embodiment of a circuit arrangement according to the
invention, the control circuit comprises

— a first circuit part for generating a signal Scorr that represents the peak amplitude of the
overshoot voltage across the output capacitor,

— a second circuit part for modulating the reference signal Sref at a modulation frequency
that equals the frequency of the commutation of the DC current by subsequently

— decreasing the reference signal Sref by an amount ΔSref during a first time interval
Δt1 that starts a second time interval Δt2 before each commutation of the DC current,

— maintaining the reference signal at the decreased value during a third time interval
Δt3,

— increasing the reference signal Sref by an amount ΔSref during a fourth time interval
Δt4,

— a third circuit part for adjusting at least one parameter chosen from the group formed by
ΔSref, Δt1, Δt2, Δt3 and Δt4 so that the amplitude of the signal Scorr is minimal.

The third circuit part in this second preferred embodiment allows a very
precise control of one or more of the dip parameters resulting in a very effective suppression
of the overshoot voltage. The adjusting of the one or more dip parameters is preferably done
by means comprised in the third circuit part for increasing and decreasing the value of the
parameter until the amplitude of the signal Scorr is minimal. Although the adjustment of only
one of the parameters until the amplitude of Scorr is minimal effects a certain suppression of
the overshoot voltage, it is preferred that the third circuit part comprises means for adjusting
at least 2 parameters chosen from the group formed by ΔSref, Δt1, Δt2, Δt3 and Δt4 so that
the amplitude of the signal Scorr is minimal.

Good results have been obtained for embodiments, wherein the third circuit
part comprises means for adjusting the parameters ΔSref, Δt2 and Δt3 so that the amplitude of
the signal Scorr is minimal. The adjustment of the parameters is preferably effected by means
of a microcontroller.

5

Embodiments of a circuit arrangement according to the invention will be explained making reference to a drawing. In the drawing

Fig. 1 shows a first embodiment of a circuit arrangement according to the invention, with a lamp connected to it;

5   Fig. 2 shows a second embodiment of a circuit arrangement according to the invention with a lamp connected to it, and

Fig. 3 shows the shape of the modulated signal Sref and the current through the lamp in the second embodiment as a function of time.

10

In Fig. 1, K1 and K2 are input terminals for connection to a supply voltage source. Input terminals K1 and K2 are connected by means of a series arrangement of a switching element Sd, an inductive element L1, an output capacitor Cout and an ohmic resistor R3. A common terminal of output capacitor Cout and ohmic resistor R3 is connected

15   to a common terminal of switching element Sd and inductor L1 by means of a diode D1. CSG is a circuit part for generating a control signal for alternately rendering switching element Sd conductive and non-conductive. An output terminal of circuit part CSG is coupled to a control electrode of switching element Sd. A first input terminal of circuit part CSG is coupled to input terminal K2. A second input terminal of circuit part CSG is

20   connected to an output terminal of circuit part ADD. Circuit part ADD is a circuit part for generating at its output terminal a signal that is the sum of a first signal present at a first input terminal of circuit part ADD and a second signal present at a second input terminal of circuit part ADD. The first input terminal of circuit part ADD is connected to an output terminal of circuit part Srefgen. Circuit part Srefgen is a circuit part for generating a reference signal

25   Sref. Output capacitor Cout is shunted by a series arrangement of capacitors C1 and C2. A common terminal of capacitors C1 and C2 is connected to a first input terminal of operational amplifier AMP by means of an ohmic resistor R1. A second input terminal of operational amplifier AMP is connected to ground potential. An output terminal of operational amplifier AMP is connected to the first input terminal of operational amplifier AMP by means of an

30   ohmic resistor R2. The output terminal of operational amplifier AMP is also directly connected to the second input terminal of circuit part ADD. The operational amplifier AMP and ohmic resistors R1 and R2 together form an amplifier. Switching element Sd, circuit part CSG, inductive element L1, output capacitor Cout, capacitors C1 and C2, diode D1, ohmic resistor R3, the amplifier, circuit part Srefgen and circuit part ADD together form a DC-DC-

6

converter for generating a DC current out of a supply voltage supplied by the supply voltage source. In the embodiment shown in Fig. 1 this DC-DC-converter is of the down-converter type. Circuit part Srefgen, ohmic resistor R3 and part of the contents of circuit part CSG together form a control loop for controlling the DC current at a value that is represented by the reference signal Sref. Capacitors C1 and C2, the amplifier and circuit part ADD together form a control circuit for adjusting the reference signal Sref. Capacitors C1 and C2, the amplifier and circuit part ADD together also form means for adjusting the reference signal in dependency of the amplitude of an AC voltage that is present across the output capacitor and is caused by the commutation of the DC current. Capacitors C1 and C2 and the amplifier together form circuitry for generating a signal Scorr that represents the amplitude of the AC voltage over the output capacitor Cout. The amplifier is layed out in such a way that the signal

(- Scorr) present at its output is proportional to the momentary amplitude of the AC voltage that is present across the output capacitor Cout but has a polarity that is opposite to the polarity of the AC voltage. For this reason the circuit part ADD generates at its output terminal a signal that equals Sref – Scorr. Therefor the amplifier together with the circuit part ADD forms circuitry for subtracting the signal Scorr from the reference signal Sref.

Output capacitor Cout is shunted by a series arrangement of swiching element S1 and switching element S2 and also by a series arrangement of switching element S3 and switching element S4. A common terminal of switching element S1 and switching element S2 is connected to a common terminal of switching element S3 and switching element S4 by means of a series arrangement of ignition inductor Lign and capacitor Cres. Capacitor Cres is shunted by an ultra high pressure discharge lamp LA connected to lamp conection terminals K3 and K4 present at respective sides of capacitor Cres. The lamp LA can for instance be a high pressure lamp or an ultra high pressure lamp such as used in beamers and projection television. Control electrodes of the switching elements S1-S4 are coupled to respective output terminals of a circuit part BC for generating control signals for controlling the conductive state of switching elements S1-S4. In Fig. 1 this coupling is indicated by means of dotted lines. Switching elements S1-S4, circuit part BC, ignition inductor Lign, lamp terminals K3 and K4 and capacitor Cres together form a commutator for commutating the DC current generated by the DC-DC-converter.

The operation of the circuit arrangement shown in Fig. 1 is as follows.

7

When the input terminals K1 and K2 are connected to a supply voltage source
that in case of the embodiment shown in Fig. 1 supplies a DC supply voltage, the circuit part
CSG generates a control signal that renders the switching element Sd alternately conductive
and non-conductive at a high frequency, for instance 100 kHz. As a result a DC voltage with
5   a lower amplitude than the DC supply voltage is present over the output capacitor Cout,
while a DC current is supplied to the commutator. The circuit part BC controls the switches
S1-S4 alternately in two different states. In the first state the switching elements S1 and S4
are conductive and the switching elements S2 and S3 are non-conductive. In the second state
the switching elements S2 and S3 are conductive and the switching elements S1 and S4 are
10 non-conductive.

When the lamp has not yet ignited, the frequency at which the circuit part BC
changes the conductive state of the switches S1-S4 is comparatively high, so that the ignition
inductor resonates with the capacitor Cres. As a result a comparatively high voltage is present
across capacitor Cres that ignites the lamp. After ignition of the lamp the frequency at which
15 the circuit part BC changes the conductive state of the switches S1-S4 is comparatively low,
for instance 90 Hz. As a result the lamp current is a low frequency substantially square wave
shaped AC current. For a very short time lapse between the two states all the switching
elements are maintained in the non-conductive state to prevent the switching elements that
are part of the same series arrangement to be conductive at the same time and thereby
20 forming a short circuit. During this very short time lapse the load of the DC-DC-converter is
zero. Before and after this very short time lapse the load of the DC-DC-converter differs from
zero. The abrupt change in the load taking place during commutation causes the output
capacitor Cout and the lamp LA to resonate. When there is no resonance between the output
capacitor Cout and the lamp LA and thus no AC voltage present across the output capacitor
25   Cout, the signal at the second input terminal of circuit part ADD is approximately equal to
zero. The signal present at the output terminal of circuit part ADD and also at the first input
terminal of circuit part CSG therefore equals Sref. The voltage over ohmic resistor R3
represents the actual value of the DC current generated by the DC-DC-converter and is
present at the second input terminal of circuit part CSG. A comparator comprised in the
30 circuit part CSG compares the signals present at the input terminals of the circuit part CSG
and generates an error signal that influences the frequency and/or the duty cycle of the
control signal generated by the circuit part CSG in such a way that the DC current is
maintained at a value that corresponds to the value of the reference signal Sref. When the
output capacitor Cout and the lamp LA resonate as a result of a commutation, an AC voltage

8

is present across output capacitor Cout. Capacitors C1 and C2 together with the amplifier
generate a signal Scorr that represents the momentary amplitude of the AC voltage that is
present across the output capacitor Cout. As explained hereabove the amplifier is layed out in
such a way that the signal (-Scorr) present at the second input terminal of circuit part ADD is

5   proportional to the amplitude of the AC voltage across the output capacitor Cout but has a
polarity that is opposite to the polarity of the AC voltage. As a consequence the signal
present at the output of circuit part ADD equals Sref – Scorr. The value of the signal present
at the first input terminal of circuit part CSG is thus decreased and as a result of that, the
amplitude of the DC current generated by the DC-DC-converter is also decreased. As a

10   consequence the resonance between the output capacitor Cout and the lamp LA is effectively
suppressed. Since the extent to which the reference signal is changed (Scorr) is directly
influenced by the momentary amplitude of the AC voltage across output capacitor Cout, the
change in the reference signal is automatically adjusted for different lamp types to a value
that corresponds to maximal resonance suppression. Similarly, when a lamp of a certain type

15   ages, the change in the reference signal (Scorr) is also adjusted automatically to realize an
effective suppression of the resonance during the whole life time of the lamp. A further
improvement can be obtained by adjusting the ratio between the signal Scorr and the
amplitude of the AC voltage in dependency of the age of the lamp. This can for instance be
realized by incorporating a timer into the circuit and controlling the gain of the amplifier in

20   dependency of the time lapse timed by the timer. It is simpler though, to incorporate in the
circuit arrangement a circuit part for generating a signal that represents lamp voltage and
decrease the gain of the amplifier when the lamp voltage increases or in other words when
the lamp ages.This gain adjustment compensates for the change in the impedance of the lamp
when it ages. It is further remarked that a filter could be incorporated into the circuit, coupled

25   between the common terminal of capacitors C1 and C2 and the amplifier for passing the AC
voltage caused by the resonance between the output capacitor Cout and the lamp LA from
other AC voltages possibly present across the output capacitor, such as the voltage ripple
caused by the switching of switching element Sd.

            In Fig. 2, components and circuit parts that are similar to components and
30   circuit parts of the circuit arrangement shown in Fig. 1 are labeled in the same way. The
topology of the circuit arrangement shown in Fig. 2 differs from that of the circuit
arrangement in Fig. 1 in that the amplifier formed by the operational amplifier AMP and the
ohmic resistors R1 and R2 has been replaced by a microprocessor µP. Additionally the
capacitors C1 and C2 have been replaced by a circuit part PD. Circuit part PD is peak

9

detector. An input terminal of circuit part PD is connected to a common terminal of output
capacitor Cout and inductive element L1. An output terminal of the circuit part PD is coupled
to an input terminal of microprocessor μP. An output terminal of microprocessor μP is
coupled to the second input terminal of circuit part ADD. The microprocessor μP together

5   with circuit part ADD forms a second circuit part part for modulating the reference signal
Sref at a modulation frequency that equals the frequency of the commutation of the DC
current by subsequently decreasing the reference signal Sref by an amount ΔSref during a
first time interval Δt1 that starts a second time interval Δt2 before each commutation of the
DC current, maintaining the reference signal at the decreased value during a third time

10   interval Δt3, and increasing the reference signal Sref by an amount ΔSref during a fourth time
interval Δt4. The moment in time referred to as commutation is the end of the commutation
process, or in other words the moment in time in which two bridge switching elements have
been rendered conductive directly after all four switching elements of the bridge circuit have
been maintained in a non-conductive state for a short time lapse.

15   The microprocessor μP also forms a third circuit part for adjusting at least one
parameter chosen from the group formed by ΔSref, Δt1, Δt2, Δt3 and Δt4 so that the
amplitude of the signal Scorr is minimal. In the embodiment shown in Fig. 2 the
microprocessor comprises means for adjusting the parameters ΔSref, Δt2 and Δt3 so that the
amplitude of the signal Scorr is minimal.

20   The operation of the circuit arrangement shown in Fig. 2 is as follows.
               During stationary operation of the circuit arrangement the DC-DC-converter
and the commutator operate in the same way as in the circuit arrangement shown in Fig. 1.
The peak detector PD comprised in the circuit arrangement in Fig. 2 generates a signal Scorr
that represents the peak amplitude of the overshoot voltage over the output capacitor Cout.

25   The peak detector can for instance comprise a circuit that samples the voltage present at the
input terminal of the circuit part PD a number of times during and after the commutation
process and subsequently selects the highest value of the sampled voltages. The value of the
signal Scorr is found by subtracting the amplitude of the DC voltage, that is present across
the across output capacitor during the major part of each half period of the lamp current, from

30   the highest value of the sampled voltages. This subtracting is done by another circuit
comprised in the circuit part PD. The microprocessor μP generates a modulation signal and
together with the circuit part ADD modulates the reference signal Sref with a frequency that
equals the commutation frequency by subsequently decreasing the reference signal Sref by an

10

amount ΔSref during a first time interval Δt1 that starts a second time interval Δt2 before each commutation of the DC current, maintaining the reference signal at the decreased value during a third time interval Δt3, and increasing the reference signal Sref by an amount ΔSref during a fourth time interval Δt4. The resulting shape of the modulated reference signal is

5 shown in Fig. 3. It can be seen that the value of Sref is constant most of the time but the modulation results in a periodical temporary decrease of the reference signal Sref. These periodical decreases start at a time interval Δt2 before commutation and have a shape that is determined by the parameters ΔSref, Δt1, Δt3 and Δt4. During the commutation process the following events take place. First, the two conductive switching elements of the bridge circuit

10 are rendered non-conductive. Subsequently all four switching elements are maintained in a non-conductive state during a short time lapse and the other two switching elements are rendered conductive.The moment in time labelled "commutation" in Figure 3 is the moment at which two switches of the bridge circuit have become conductive again (in other words the end of the comutation process). Fig. 3 also shows the shape of the lamp current as a function

15 of time. The lamp current has a constant amplitude most of the time. A time lapse Δt2 before each commutation the amplitude decreases during the time interval Δt1. The amplitude of the lamp current is then maintained at a constant value during the time interval Δt3. In the example in Fig. 3 the moment in time labelled "commutation" is in the course of the time interval Δt3. After the time interval Δt3 the amplitude of the lamp current increases back to

20 its original value during the time interval Δt4. It is noteworthy that Δt1 is not necessarily equal to Δt4 and that the moment in time labelled "commutation" is not necessarily precisely situated in the middle of the time interval Δt3 but may at another time depending on for instance the value of Δt2.

During operation of the circuit arrangement, the microprocessor adjusts the

25 values of the parameters ΔSref, Δt2 and Δt3 continuously in the following way. The value of the signal Scorr is saved in a memory. Subsequently parameter ΔSref is increased by a predetermined amount and the value of the signal Scorr after the increase of ΔSref is compared with the value before the increase that was saved in the memory. In case the signal Scorr is decreased as a result of the increase of ΔSref, the new value of Scorr is saved in the

30 memory by overwriting the previous value and ΔSref is increased once more by the predetermined amount. This procedure is repeated until an increase in ΔSref causes the signal Scorr to increase. In the latter case ΔSref is decreased by the predetermined amount and the resulting value of Scorr is saved in the memory by overwriting the previous value. In

11

case the first increase of ΔSref causes an increase in the signal Scorr the microprocessor
decreases the value ΔSref until a further decrease causes an increase in the signal Scorr. The
signal Scorr is thus minimalized by adjusting the parameter ΔSref. The microprocessor
subsequently increases and decreases the parameter $\Delta t2$ until a minimal value of the signal

5   Scorr results, in the same way as outlined hereabove for the parameter ΔSref. After the
adjustment of parameter $\Delta t2$, parameter $\Delta t3$ is adjusted at a value corresponding to a minimal
value of the signal Scorr. After the adjustment of parameter $\Delta t3$ the microprocessor
subsequently adjusts ΔSref, $\Delta t2$ and $\Delta t3$ again etc. Because of the continuous adjustment of
the parameters ΔSref, $\Delta t2$ and $\Delta t3$ the modulation of the reference signal Sref is

10   continuously and automatically adapted to different lamps that are operated by means of the
circuit arrangement. Similarly the changes in lamp properties with life time are continuously
and automatically accounted for. As a result a maximal suppression of overshoot voltage is
obtained for many different lamp types during their whole life time. Since the parameters
determining the shape of the modulation of the reference signal Sref can be adjusted

15   independently from each other, the shape of the modulation can be changed in many different
ways resulting in practice in a very effective suppression of the overshoot voltage.

Merely by way of example the functioning of the circuit arrangement shown in
Fig. 2 was described for an embodiment in which the parameters ΔSref, $\Delta t2$ and $\Delta t3$ are
adjusted. Of course it is possible to let the microprocessor adjust all 5 parameters or

20   otherwise less than 3 parameters. Adjustment of more parameters will generally lead to a
better suppression of the overshoot voltage.

12

CLAIMS:

1.   Circuit arrangement for operating a high pressure discharge lamp comprising
  -   input terminals for connection to a supply voltage source,
  -   a DC-DC-converter coupled to the input terminals for generating a DC current out of a
      supply voltage supplied by the supply voltage source and comprising
5 -   a control loop for controlling the DC current at a value that is represented by a reference
      signal Sref,
  -   a control circuit for adjusting the reference signal Sref, and
  -   an output capacitor,
  -   a commutator for commutating the DC current and comprising lamp connection terminals,
10 characterized in that the control circuit comprises means for adjusting the reference signal
    Sref in dependency of the amplitude of a periodical voltage that is present across the output
    capacitor and is caused by the commutation of the DC current.

2.   Circuit arrangement according to claim 1, wherein the control circuit
15 comprises circuitry for generating a signal Scorr that represents the momentary amplitude of
    an AC voltage across the output capacitor and circuitry for subtracting the signal Scorr from
    the reference signal Sref.

3.   Circuit arrangement according to claim 2, wherein the signal Scorr is
20 proportional to the momentary amplitude of the AC voltage across the output capacitor.

4.   Circuit arrangement according to claim 3, wherein the circuit arrangement is
    equipped with circuitry for adjusting the ratio between the signal Scorr and the momentary
    amplitude of the AC voltage across the output capacitor in dependency of the age of the
25 lamp.

5.   Circuit arrangement according to claim 4, wherein the circuit arrangement is
    equipped with circuitry for adjusting the ratio between the signal Scorr and the momentary
    amplitude of the AC voltage across the output capacitor in dependency of the lamp voltage.

13

6.   Circuit arrangement according to claim 1, 2, 3, 4 or 5, wherein the control
circuit comprises
    –   a first circuit part for generating a signal Scorr that represents the peak amplitude of the
5   overshoot voltage across the output capacitor,
    –   a second circuit part for modulating the reference signal Sref at a modulation frequency
         that equals the frequency of the commutation of the DC current by subsequently
         –   decreasing the reference signal Sref by an amount ∆Sref during a first time interval
              ∆t1 that starts a second time interval ∆t2 before each commutation of the DC current,
10   –   maintaining the reference signal at the decreased value during a third time interval
              ∆t3,
         –   increasing the reference signal Sref by an amount ∆Sref during a fourth time interval
              ∆t4,
    –   a third circuit part for adjusting at least one parameter chosen from the group formed by
15   ∆Sref, ∆t1, ∆t2, ∆t3 and ∆t4 so that the amplitude of the signal Scorr is minimal.

7.   Circuit arrangement according to claim 6, wherein the third circuit part
comprises means for increasing and decreasing the value of the parameter until the amplitude
of the signal Scorr is minimal.

20
8.   Circuit arrangement according to claim 6 or 7, wherein the third circuit part
comprises means for adjusting at least 2 parameters chosen from the group formed by ∆Sref,
∆t1, ∆t2, ∆t3 and ∆t4 so that the amplitude of the signal Scorr is minimal.

25 9.   Circuit arrangement according to claim 8, wherein the third circuit part
comprises means for adjusting the parameters ∆Sref, ∆t2 and ∆t3 so that the amplitude of the
signal Scorr is minimal.

10.   Circuit arrangement according to claims 6, 7, 8 or 9, wherein the third circuit
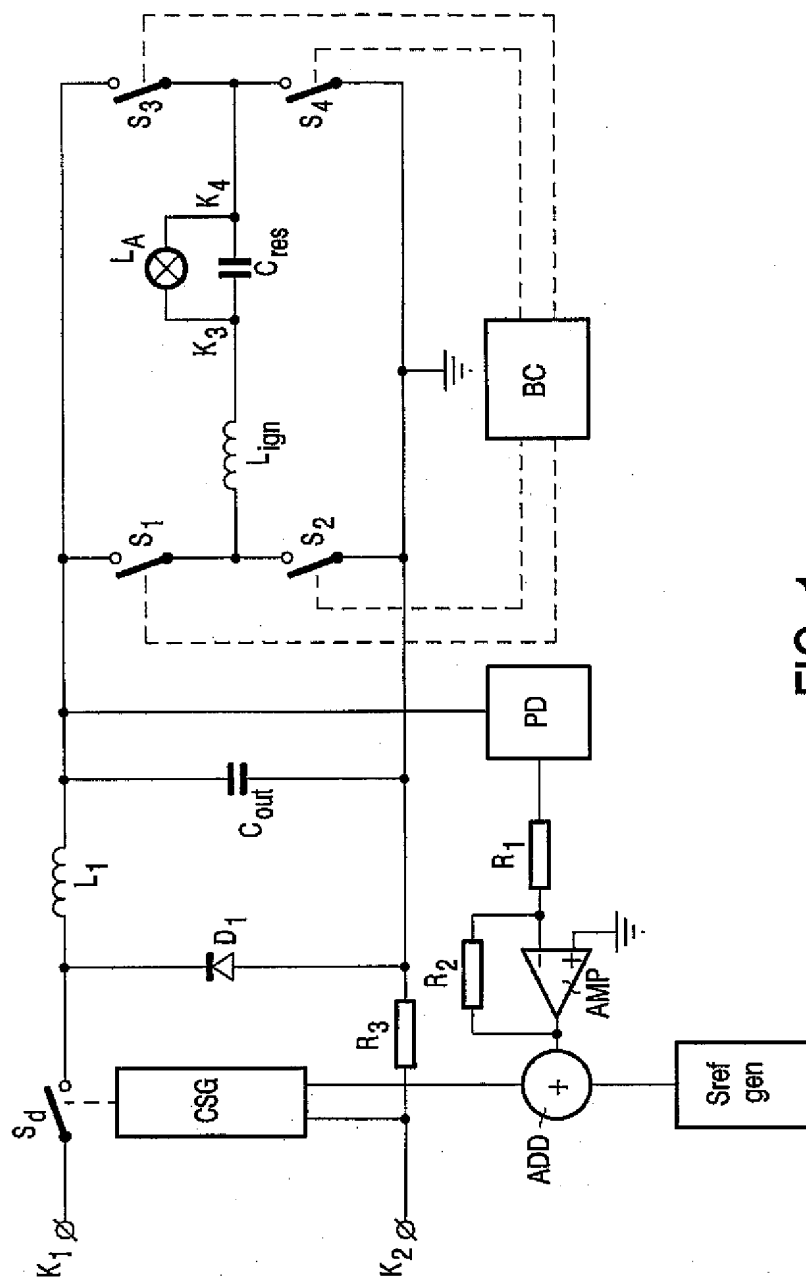30 part comprises a microcontroller.
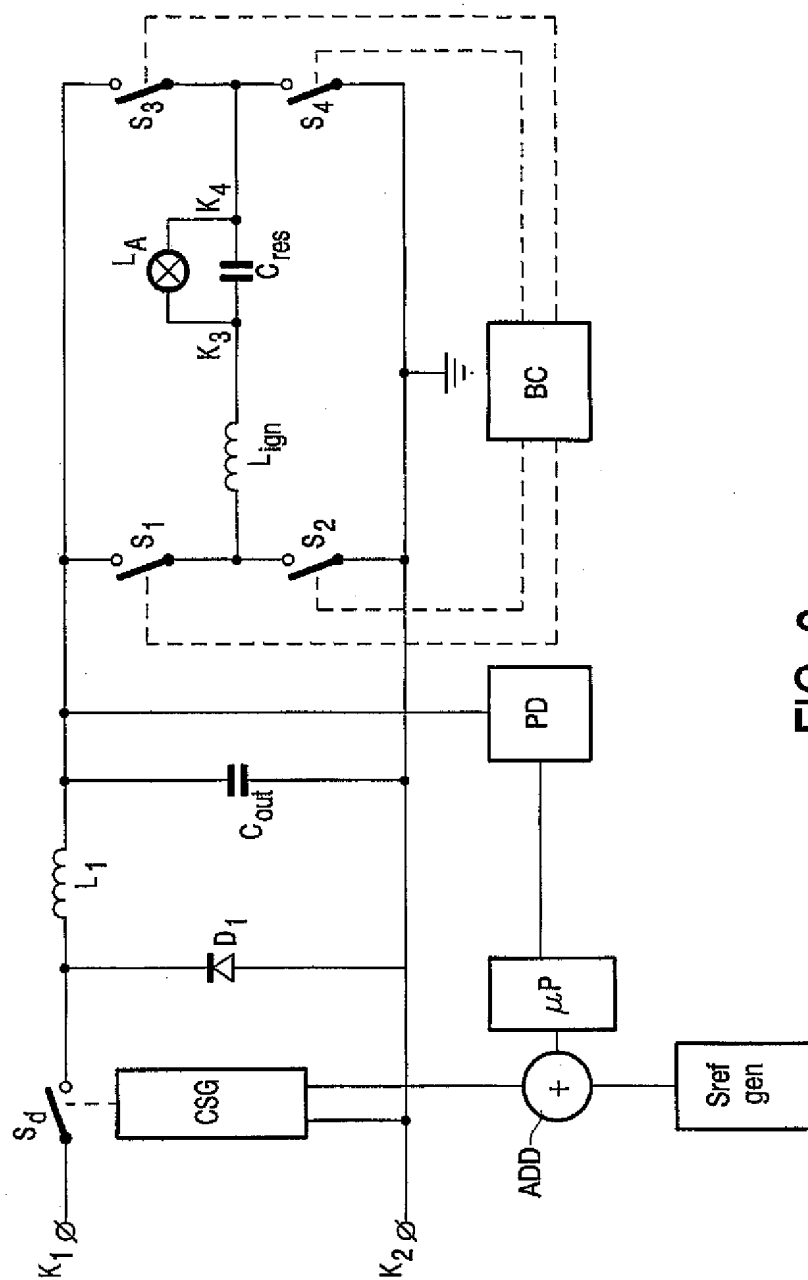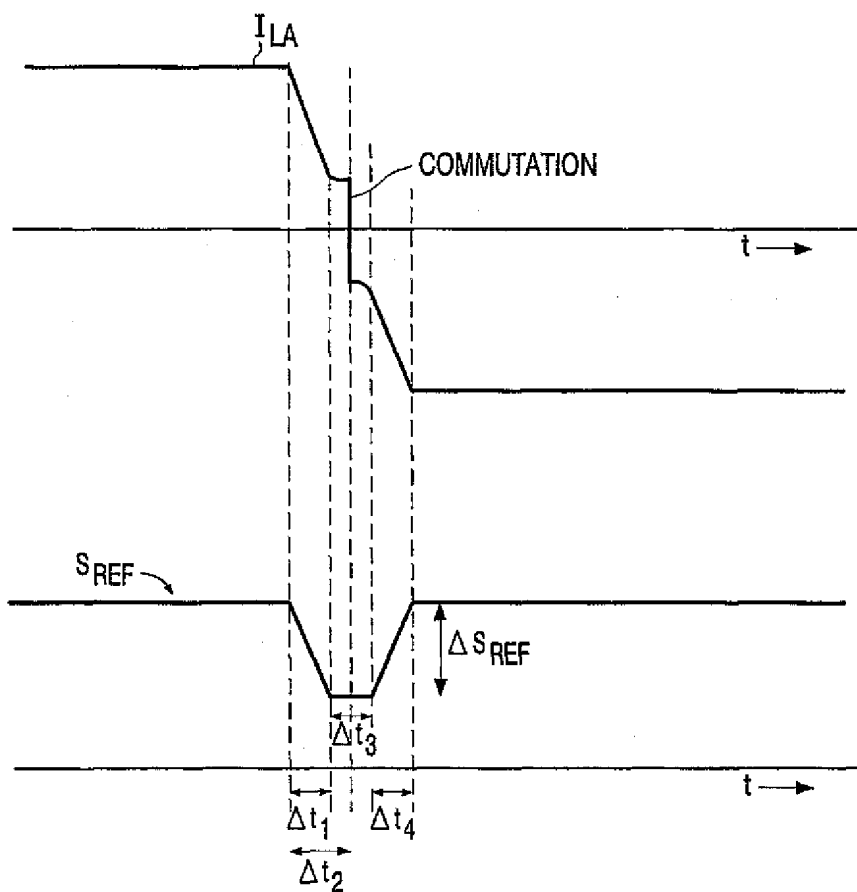
1/3

FIG. 1
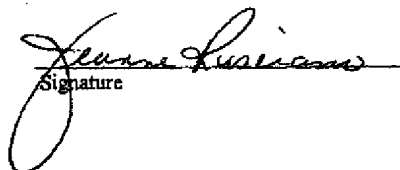
2/3

FIG. 2

FIG. 3

Exhibit B

FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NO. NL 021105
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	U.S. Application No. (if known, see 37 CFR 1.5)

INTERNATIONAL APPLICATION NO. PCT/IB2003/05015	INTERNATIONAL FILING DATE November 6, 2003	PRIORITY DATE CLAIMED November 11, 2002

TITLE OF INVENTION
CIRCUIT ARRANGEMENT FOR OPERATING A HIGH PRESSURE DISCHARGE LAMP

APPLICANT(S) FOR DO/EO/US
Roy Hendrik Anna Maria VAN ZUNDERT; Thijs OOSTERBAAN; Dolf Henricus Jozef VAN CASTEREN

Applicant(s) herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.

2. [ ] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.

3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] copy of the International Application as filed (35 U.S.C. 371 (c)(2))
    a. [ ]   is transmitted herewith (required only if not transmitted by the International Bureau).
    b. [X]   has been transmitted by the International Bureau.
    c. [ ]   is not required, as the application was filed in the United States Receiving Office (RO/US).

6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
    a. [ ]   are transmitted herewith (required only if not transmitted by the International Bureau).
    b. [ ]   have been transmitted by the International Bureau.
    c. [ ]   have not been made; however, the time limit for making such amendments has NOT expired.
    d. [X]   have not been made and will not be made.

8. [ ] A translation of the amendment to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).

9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.

12. [X] An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.

13. [X] A FIRST preliminary amendment.
    [ ] A SECOND OR SUBSEQUENT preliminary amendment.

14. [ ] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information:

    X   Power of Attorney to Prosecute Application Before the USPTO [PTO/SB/80]
    X   Statement under 37 CFR 3.73(b) [PTO/SB/96]
    X   Authorization Pursuant to 37 CFR § 1.136(a)(3) and to Charge Deposit Account

CERTIFICATE OF MAILING

[X] Express Mail Mailing Label No. EV664852427-US
Date of Deposit 5-9-05

I hereby certify that this paper and fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Jeanne Rusciano
Typed Name

Signature

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO. PCT /IB2003/050015	ATTORNEY'S DOCKET NUMBER NL 021105

17 [X] The following fees are submitted:

BASIC NATIONAL FEE (37 C.F.R. 1.492(A)(1)-(5)):

		CALCULATIONS (PTO USE ONLY)
Search Report has been prepared by the EPO or JPO	$1000.00	
International preliminary-examination fee paid to USPTO (37 C.F.R. 1.482)	$680.00	
No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2)	$750.00	
Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO	$970.00	
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)	$ 96.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =		$ 1000.00

Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	19 - 20 =	0	X $ 50.00	$ 0.00	
Independent claims	1 - 3 =	0	X $ 200.00	$ 0.00	
MULTIPLE DEPENDENT CLAIMS (if applicable)			+ $ 360.00	$ 0.00	
TOTAL OF ABOVE CALCULATIONS =				$ 0.00	
Reductions by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 C.F.R. 1.9, 1.27, 1.28)				$	
SUBTOTAL =				$ 1000.00	
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 1000.00	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28,3.31). $40.00 per property +				$ 40.00	
TOTAL FEES ENCLOSED =				$ 1040.00	
				Amount to be Refunded	$
				Charged	$

a. [ ] A check in the amount $_____ to cover the above fees is enclosed.

b. [X] Please charge my Deposit Account No. _14-1270_ in the amount of $_1040.00_ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fee, with the exception of the Base Issue Fee, which may be required, or credit any overpayment to Deposit Account No. _14-1270_. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Corporate Patent Counsel
Philips Electronics North America Corporation
P.O. Box 3001
Briarcliff Manor, NY 10510

[SIGNATURE]

Robert J. Kraus
(NAME)

26.358
[REGISTRATION NUMBER)

C:\JR\0FORMS\pctcov.wp.doc

Exhibit C

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: ˙ _ ˙ . ˙ ˙ the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No _____

on _____

and was amended

on _____

☒ was filed as PCT international application

Number   PCT/IB2003/050015 _____

on   06 November 2003 _____

and was amended under PCT Article 19

on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 USC 119
Europe	**02079686.8**	**11 November 2002**	**YES**

Combined Declaration For Patent Application and Power of Attorney (Continued) · (includes Reference to PCT International Applications)	Attorneys Docket Number **PHNL021105 US**

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

Jack E. Haken, Reg. No. 26,902 Michael E. Marion, Reg. No. 32, 266 Edward M. Blocker, Reg. No. 30,245	Direct Telephone Calls to: (name and telephone number) **(914)332-0222**

		FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
201	FULL NAME OF INVENTOR	**VAN ZUNDERT**	**Roy**	**Hendrik Anna Maria**
	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**
202	FULL NAME OF INVENTOR	**OOSTERBAAN**	**Thijs**	
	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**
203	FULL NAME OF INVENTOR	**VAN CASTEREN**	**Dolf**	**Henricus Jozef**
	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 if Title 18 of the United states Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE 09 June 2004	DATE	DATE

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER PHNL021105 US

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: ⬝ . ⬝⬝ the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No _____

on _____

and was amended

on _____

☒ was filed as PCT international application

Number   PCT/IB2003/050015 _____

on   06 November 2003 _____

and was amended under PCT Article 19

on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 USC 119
Europe	**02079686.8**	**11 November 2002**	**YES**

Combined Declaration For Patent Application and Power of Attorney (Continued) (includes Reference to PCT International Applications)	Attorneys Docket Number **PHNL021105 US**

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

Jack E. Haken, Reg. No. 26,902 Michael E. Marion, Reg. No. 32, 266 Edward M. Blocker, Reg. No. 30,245	Direct Telephone Calls to: (name and telephone number) **(914)332-0222**

		FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	FULL NAME OF INVENTOR	**VAN ZUNDERT**	**Roy**	**Hendrik Anna Maria**
201	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**
	FULL NAME OF INVENTOR	**OOSTERBAAN**	**Thijs**	
202	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**
	FULL NAME OF INVENTOR	**VAN CASTEREN**	**Dolf**	**Henricus Jozef**
203	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 if Title 18 of the United states Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE	DATE 11 June 2004	DATE

U.S. DEPARTMENT OF COMMERCE- Patent and Trademarks Office

(July 1994)

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER **PHNL021105 US**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: ‾ ‾ ‾ ‾ the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No _____

on _____

and was amended

on _____

☒ was filed as PCT international application

Number   PCT/IB2003/050015

on   06 November 2003

and was amended under PCT Article 19

on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 USC 119
Europe	**02079686.8**	**11 November 2002**	**YES**

Combined Declaration For Patent Application and Power of Attorney (Continued) (Includes Reference to PCT International Applications)	Attorneys Docket Number **PHNL021105 US**

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

Jack E. Haken, Reg. No. 26,902 Michael E. Marion, Reg. No. 32, 266 Edward M. Blocker, Reg. No. 30,245	Direct Telephone Calls to: (name and telephone number) **(914)332-0222**

		FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
201	FULL NAME OF INVENTOR	**VAN ZUNDERT**	**Roy**	**Hendrik Anna Maria**
	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**
202	FULL NAME OF INVENTOR	**OOSTERBAAN**	**Thijs**	
	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**
203	FULL NAME OF INVENTOR	**VAN CASTEREN**	**Dolf**	**Henricus Jozef**
	RESIDENCE & CITIZENSHIP	CITY **Eindhoven**	STATE OR FOREIGN COUNTRY **The Netherlands**	COUNTRY OF CITIZENSHIP **The Netherlands**
	POST OFFICE ADDRESS	POST OFFICE ADDRESS **Prof. Holstlaan 6**	CITY **5656 AA Eindhoven**	STATE & ZIP CODE/COUNTRY **The Netherlands**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 if Title 18 of the United states Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE	DATE	DATE 14 June 2004

U.S. DEPARTMENT OF COMMERCE- Patent and Trademarks Office

(July 1994)

Exhibit D

For good and valuable consideration, of which I acknowledge receipt, I, as a below-named assignor, sell and assign to Koninklijke Philips Electronics N.V. (hereinafter "Assignee") a corporation existing under the laws of the Kingdom of the Netherlands, whose business address is Groenewoudseweg 1, 5621 BA Eindhoven, the Netherlands, its successors and assigns, the application for a United States Patent for the improvements in a invented by us, which application:

☐ is executed concurrently herewith

☐ was executed by me/us on ....

☐ is Serial No. .... filed ....

☒ is International Application No. PCT/IB2003/050015 filed 06 November 2003.,

and all rights in and to said application, and all Patents which may be granted therefor, and all divisions, reissues, continuations and extensions thereof, and authorize and request the Commissioner of Patents and Trademarks to issue all Patents on said improvements or resulting therefrom to said Assignee as assignee of the entire interest and covenant that I have full right so to do, and agree that I will communicate to said Assignee or its representatives any facts known to me respecting said improvements and testify in any legal proceeding, sign all lawful papers, execute all divisional, continuing and reissue applications, make all rightful oaths and generally do everything possible to aid said Assignee, its successors, assigns and nominees, to obtain and enforce proper protection for said invention.

| 09 June 2004 | (sign name here) | | , Assignor |
| Date | (print name here) | Roy Hendrik Anna Maria VAN ZUNDERT | |

| | (sign name here) | | , Assignor |
| Date | (print name here) | Thijs OOSTERBAAN | |

| | (sign name here) | | , Assignor |
| Date | (print name here) | Dolf Henricus Jozef VAN CASTEREN | |

Exhibit E

MARCH 24, 2006

PTAS

103139761A

PHILIPS ELECTRONICS NORTH AMERICA
 CORPORATION
P.O. BOX 3001
BRIARCLIFF MANOR, NY 10510-8001

UNITED STATES PATENT AND TRADEMARK OFFICE
NOTICE OF RECORDATION OF ASSIGNMENT DOCUMENT

THE ENCLOSED DOCUMENT HAS BEEN RECORDED BY THE ASSIGNMENT DIVISION OF
THE U.S. PATENT AND TRADEMARK OFFICE. A COMPLETE MICROFILM COPY IS
AVAILABLE AT THE ASSIGNMENT SEARCH ROOM ON THE REEL AND FRAME NUMBER
REFERENCED BELOW.

PLEASE REVIEW ALL INFORMATION CONTAINED ON THIS NOTICE. THE
INFORMATION CONTAINED ON THIS RECORDATION NOTICE REFLECTS THE DATA
PRESENT IN THE PATENT AND TRADEMARK ASSIGNMENT SYSTEM. IF YOU SHOULD
FIND ANY ERRORS OR HAVE QUESTIONS CONCERNING THIS NOTICE, YOU MAY
CONTACT THE EMPLOYEE WHOSE NAME APPEARS ON THIS NOTICE AT 571-272-3350.
PLEASE SEND REQUEST FOR CORRECTION TO: U.S. PATENT AND TRADEMARK OFFICE,
MAIL STOP: ASSIGNMENT SERVICES BRANCH, P.O. BOX 1450, ALEXANDRIA, VA 22313.

RECORDATION DATE: 05/09/2005   REEL/FRAME: 017357/0653
                              NUMBER OF PAGES: 4

BRIEF: ASSIGNMENT OF ASSIGNOR'S INTEREST (SEE DOCUMENT FOR DETAILS).

ASSIGNOR:
    VAN ZUNDERT, ROY HENDRIK ANNA   DOC DATE: 06/09/2004
      MARIA

ASSIGNOR:
    OOSTERBAAN, THIJS   DOC DATE: 06/11/2004

ASSIGNOR:
    VAN CASTEREN, DOLF HENRICUS JOZEF   DOC DATE: 06/14/2004

ASSIGNEE:
    KONINKLIJKE PHILIPS ELECTRONICS,
      N.V.
    GROENEWOUDSEWEG 1
    EINDHOVEN, NETHERLANDS 5621 BA

Scanned by VK 3

Wrong application

SERIAL NUMBER: 10534318   FILING DATE: 05/09/2005
PATENT NUMBER: ISSUE DATE:
TITLE: MAGNETIC RESONANCE IMAGING SYSTEM WITH A PLURALITY OF TRANSMIT COILS

MARY BENTON, EXAMINER
ASSIGNMENT SERVICES BRANCH
PUBLIC RECORDS DIVISION

Exhibit F

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	Atty. Docket
ROY H.A.M. VAN ZUNDERT et al.	NL 021105
Serial No.	Group Art Unit
Filed: CONCURRENTLY	Ex.

CIRCUIT ARRANGEMENT FOR OPERATING A HIGH PRESSURE DISCHARGE LAMP

Commissioner for Patents
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Sir:

Prior to calculation of the filing fee and examination, please amend the above-identified application as follows:

IN THE CLAIMS

Please amend the claims as follows:

1.   (original)   Circuit arrangement for operating a high pressure discharge lamp comprising

–   input terminals for connection to a supply voltage source,

–   a DC-DC-converter coupled to the input terminals for generating a DC current out of a supply voltage supplied by the supply voltage source and comprising

–   a control loop for controlling the DC current at a value that is represented by a reference signal Sref,

–   a control circuit for adjusting the reference signal Sref, and

–   an output capacitor,

–   a commutator for commutating the DC current and comprising lamp connection terminals,

characterized in that the control circuit comprises means for adjusting the reference signal Sref in dependency of the amplitude of a periodical voltage that is present across the output capacitor and is caused by the commutation of the DC current.

2.   (original)   Circuit arrangement according to claim 1, wherein the control circuit comprises circuitry for generating a signal Scorr that represents the momentary amplitude of an AC voltage

across the output capacitor and circuitry for subtracting the signal Scorr from the reference signal Sref.

3. (original) Circuit arrangement according to claim 2, wherein the signal Scorr is proportional to the momentary amplitude of the AC voltage across the output capacitor.

4. (original) Circuit arrangement according to claim 3, wherein the circuit arrangement is equipped with circuitry for adjusting the ratio between the signal Scorr and the momentary amplitude of the AC voltage across the output capacitor in dependency of the age of the lamp.

5. (original) Circuit arrangement according to claim 4, wherein the circuit arrangement is equipped with circuitry for adjusting the ratio between the signal Scorr and the momentary amplitude of the AC voltage across the output capacitor in dependency of the lamp voltage.

6. (currently amended) Circuit arrangement according to claim 1, 2, 3, 4 or 5, wherein the control circuit comprises

- a first circuit part for generating a signal Scorr that represents the peak amplitude of the overshoot voltage across the output capacitor,

- a second circuit part for modulating the reference signal Sref at a modulation frequency that equals the frequency of the commutation of the DC current by subsequently

  - decreasing the reference signal Sref by an amount ΔSref during a first time interval Δt1 that starts a second time interval Δt2 before each commutation of the DC current,

  - maintaining the reference signal at the decreased value during a third time interval Δt3,

  - increasing the reference signal Sref by an amount ΔSref during a fourth time interval Δt4,

- a third circuit part for adjusting at least one parameter chosen from the group formed by ΔSref, Δt1, Δt2, Δt3 and Δt4 so that the amplitude of the signal Scorr is minimal.

7.   (original) Circuit arrangement according to claim 6, wherein the third circuit part comprises means for increasing and decreasing the value of the parameter until the amplitude of the signal Scorr is minimal.

8. (currently amended) Circuit arrangement according to claim 6 ~~or 7~~, wherein the third circuit part comprises means for adjusting at least 2 parameters chosen from the group formed by $\Delta Sref$, $\Delta t1$, $\Delta t2$, $\Delta t3$ and $\Delta t4$ so that the amplitude of the signal Scorr is minimal.

9. (original) Circuit arrangement according to claim 8, wherein the third circuit part comprises means for adjusting the parameters $\Delta Sref$, $\Delta t2$ and $\Delta t3$ so that the amplitude of the signal Scorr is minimal.

10. (currently amended) Circuit arrangement according to ~~claims 6, 7, 8 or 9~~claim 6, wherein the third circuit part comprises a microcontroller.

REMARKS

The foregoing amendments to the claims were made solely to avoid filing the claims in the multiple dependent form so as to avoid the additional filing fee.

The claims were not amended in order to address issues of patentability and Applicants respectfully reserve all rights they may have under the Doctrine of Equivalents. Applicants furthermore reserve their right to reintroduce subject matter deleted herein at a later time during the prosecution of this application or continuing applications.
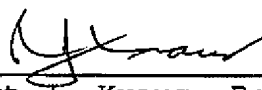
Respectfully submitted,

By _____

Robert J. Kraus, Reg. 26,358
Attorney
(914) 333-9634

Exhibit G

(51) International Patent Classification⁷: G01R 33/36

(21) International Application Number:
PCT/IB2003/005015

(22) International Filing Date:
4 November 2003 (04.11.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
02080152.8   6 December 2002 (06.12.2002)   EP

(71) Applicant (for all designated States except US): KONIN-KLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and
(75) Inventors/Applicants (for US only): HAM, Cornelis, L.,

G. [NL/NL]; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). FUDERER, Miha [BE/NL]; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(74) Agent: WOLFS, Marc, J., M.; Philips Intellectual Property & Standards, Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,

[Continued on next page]

(54) Title: MAGNETIC RESONANCE IMAGING SYSTEM WITH A PLURALITY OF TRANSMIT COILS
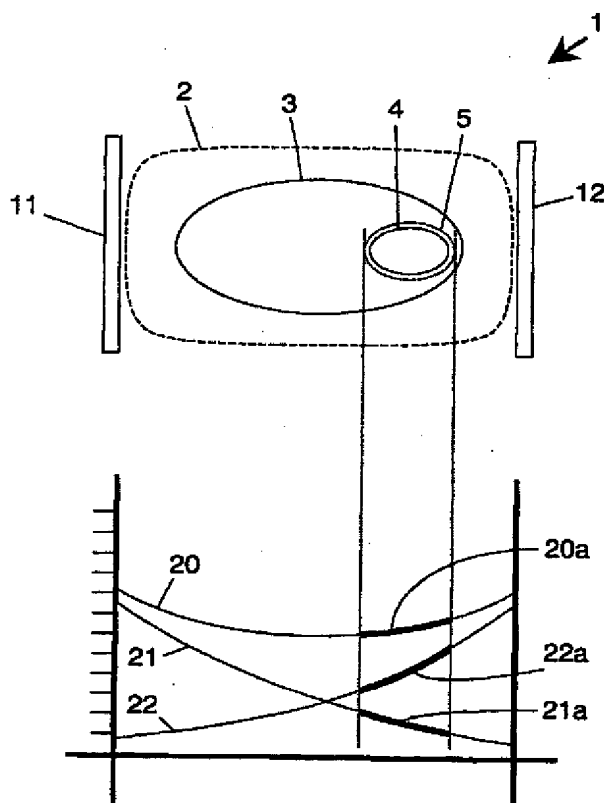
(57) Abstract: The invention relates to an MRI system (1) for nuclear magnetic resonance imaging which comprises a plurality of transmit coils (11, 12). Each coil receives a coil drive signal (SD1, SD2). The respective coil drive signals have the same shape, but may have a different amplitude and phase, controlled by a controller (103) on the basis of characteristic information in a memory (104) as well as user input information. The controller is designed to set the respective amplitudes and phases in such a way that the resultant overall B1 field is as homogeneous as possible in a volume of interest.

WO 2004/053514 A1

ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent* (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Magnetic resonance imaging system

MAGNETIC RESONANCE IMAGING SYSTEM WITH A PLURALITY OF TRANSMIT COILS

The invention relates to a magnetic resonance imaging (MRI) system comprising:

-        an object space for receiving an object to be examined;

-        a main magnet system for generating a main magnetic field in the object

5   space;

-        a gradient magnet system for generating gradients of the main magnetic field in the object space;

-        a plurality of transmit coils located adjacent the object space;

-        a coil drive circuit for generating a plurality of individual coil drive signals.

10

In the magnetic resonance imaging (MRI) technique, proton spins of a body under examination, for example a human body, are excited; after excitation, the spins return to their equilibrium state and in this process they transmit an electromagnetic field which is

15   called a free induction decay signal (FID). This FID signal can be received and MR images derived therefrom. Since the MR imaging technique is well known per se and the present invention does not relate to the MR imaging technique as such, the MR imaging technique will not be explained in more detail, herein.

In the magnetic resonance imaging technique, a magnetic field is applied to

20   the object under observation, the magnetic field having several components. The B0 field is a strong, static field which aligns the spins in a state of equilibrium. The B1 field is a high frequency field (normally a pulsed field) which excites the spins out of their state of equilibrium. The frequency of the B1 field depends on the application; it is usually in the radio frequency range (RF). Furthermore, gradient fields Gx, Gy and Gz are applied.

25   The B1 field may have components in X- and Y-directions, perpendicular to each other and to the B0 field direction. The B1X and B1Y fields may exhibit a certain predetermined phase relationship with respect to each other.

As is commonly recognized, it is desirable that the B1 field is homogeneous or uniform within a certain measuring volume. This means that the spins of the nuclei in a volume of interest are all excited to the same extent by the magnetic field.

MRI systems comprise transmit means, including transmit antennas or coils,
5   for generating the magnetic field to be applied to the body under examination, and receive means, including receive antennas or coils, for receiving the signals transmitted by the nuclei of such a body. The desirability of a homogeneous B1 field implies the desirability of a transmit antenna having a homogeneous transmit characteristic. Furthermore, for measuring integrity it is desirable that the receive antenna has a homogeneous sensitivity characteristic,
10   meaning that the receive antenna is sensitive to the same extent to all nuclei within the volume of interest. If the receiver has an inhomogeneous sensitivity characteristic, it is usually possible to compensate for this aspect in subsequent image processing. However, if the transmit antenna has an inhomogeneous sensitivity characteristic, one consequence will be that different portions within the volume of interest will be excited in a different manner;
15   the differences in excitation may then depend on the deviations from homogeneity in a non-linear way. This may lead to a loss of contrast in some portions of the volume of interest.

Therefore, a general objective of the present invention is to provide an MRI system of the kind mentioned in the opening paragraph with improved homogeneity of the B1 field.

20   A complicating factor in this respect is that the object in the volume of interest may have an effect on the B1 field. Due to its electrical properties, this is especially the case for human tissue. Even if the transmit antenna were to have an ideal homogeneous characteristic, the magnetic field within the object under observation might be inhomogeneous due to distortions caused by the object itself. Such distortions may be due to,
25   for example, internal resonances within the object, or to absorption by the object.

A usual approach for compensating absorption is to increase transmit power. However, one obvious disadvantage is an increase in power dissipation in the object under investigation, which is especially undesirable in the case of examination of a human patient.

Therefore, the present invention aims to improve the homogeneity of the B1
30   field without substantially increasing overall transmit power, preferably even while reducing overall transmit power.

The desirability of a uniform B1 field has already been recognized in prior art. Previously proposed solutions include, for instance, the use of composite RF pulses or the use of adiabatic pulses. Both approaches involve a substantial increase in RF dissipation within

the object under observation. Furthermore, composite RF pulses can only be used for a
limited number of pulse types, for instance 90° pulses and 180° pulses; composite RF pulses
do not solve the problem of providing, for instance, homogeneous 30° pulses.

5   US-A-6.049.206 describes a complicated method which involves providing an
initial, non-homogeneous B1 pulse and an additional pulse which consists of a phase
modulation of the initial B1 pulse and has a time-dependent phase relationship with respect to
the initial B1 pulse. Such an approach, besides being complicated, is only suitable for
specific pulse types, specifically 90° pulses and 180° pulses.

10

        An object of the present invention is to provide a magnetic resonance imaging
system of the kind mentioned in the opening paragraph in which the homogeneity of the B1
field is improved with relatively simple means.

        In order to achieve said object, a magnetic resonance imaging (MRI) system in
15   accordance with the present invention is characterized in that the individual coil drive signals
are generated by the coil drive circuit so as to have a substantially identical shape, the system
having controllable means for individually setting the amplitude and/or phase of each of said
coil drive signals, and a controller for controlling said controllable means. In an MRI system
according to the invention the transmit means comprise at least two transmit antennas or
20   coils. The individual antennas are driven by an RF pulse derived from one basic signal, but
weighted by individual weighing factors, in such a way that the resultant overall B1 field is
substantially homogeneous within the volume of interest.

25   These and other aspects, features and advantages of the present invention will
be further explained by the following description of the present invention with reference to
the drawings, in which corresponding reference numerals indicate corresponding or similar
parts, and in which:

        Fig. 1 schematically illustrates an arrangement of two coils and the resultant
30   magnetic field in an object space;

        Fig. 2 is comparable to fig. 1, illustrating the effect of the invention on the
homogeneity of the magnetic field; and

        Fig. 3 is a block diagram schematically illustrating an embodiment of a coil
drive circuit.

Fig. 1 schematically illustrates an MRI system 1 according to the invention which is used to form images of the intestines of, for example, a human body by means of nuclear magnetic resonance (NMR) techniques. The MRI system 1 has an object space 2 for receiving an object 3 to be examined. The MRI system 1 also comprises a main magnet system for generating a main magnetic field in the object space 2, and a gradient magnet system for generating gradients of the main magnetic field in the object space 2. The main magnet system and the gradient magnet system are not shown in Fig. 1 because the exact structure and details of the main magnet system and the gradient magnet system are not relevant for the present invention. The main magnet system and the gradient magnet system may be of a kind known to and generally used by a person skilled in the art of magnetic resonance imaging systems. The MRI system 1 comprises first and second transmit antennas 11 and 12, hereinafter indicated briefly as "coils", each designed for generating an RF magnetic field. The two coils 11 and 12 are located on opposite sides of the object space 2. An object located in the object space 2 is generally indicated by the reference 3; this object may for instance be a human body. An object part within the object 3 is generally indicated by the reference 4; this object part may for instance be a human liver. In the following explanation it is assumed that it is desired to obtain an image of the liver of a human being; thus, a volume of interest 5 is defined by object part 4. The volume of interest 5 may in principle be identical to the volume occupied by the liver, but in this case, for easy reference, the volume of interest 5 is taken to be slightly larger than the volume of the liver 4.

Fig. 1 also shows a graph containing curves 21 and 22 indicating the local field strength of the magnetic field generated by the first coil 11 and the second coil 12, respectively. The horizontal axis of this graph indicates location and is aligned with the schematic drawing of the MRI system 1.

It can clearly be seen from the curve 21 of this graph that the first coil 11 generates a non-homogeneous field having its highest intensity coinciding with the location of the first coil 11 and generally decreasing with distance. Especially the magnetic field generated by the first coil 11 is not homogeneous at the location of the volume of interest 5 (see part 21a of the curve 21).

Likewise, it can clearly be seen from the curve 22 of this graph that the second coil 12 generates a non-homogeneous field having its highest intensity coinciding with the location of the second coil 12 and generally decreasing with distance. Especially the

magnetic field generated by the second coil 12 is not homogeneous at the location of the volume of interest 5 (see part 22a of the curve 22).

It is noted that, in this example, the curves 21 and 22 are identical; however, although such is preferred, it is not essential for the present invention.

5   The overall B1 field generated by the coils 11 and 12, i.e. a direct summation of the fields 21 and 22, is shown at 20 in the graph of Fig. 1. In the state of the art, both coils 11 and 12 generate the same field strength, i.e. they receive substantially the same amount of power, as illustrated by the curve 20. It can clearly be seen in this case that the B1 field 20 is not homogeneous at the location of the volume of interest 5 (see part 20a of the curve 20).

10   The B1 field 20 has a minimum, around which the B1 field is substantially homogeneous, but this minimum has a fixed location within the object space 2, which location does not necessarily correspond to the location of the volume of interest 5.

Fig. 2 is comparable to Fig. 1, except that the graph illustrates a situation where the overall power applied to the coils is redistributed such that the first coil 11 receives

15   more power and the second coil 12 receives less power as indicated by the first field curve 21 which is raised and the second field curve 22 which is lowered relative to their positions in figure 1. The redistribution of power can be done such that the overall amount of power remains the same. According to the principles of the present invention, the redistribution of power is done in such a way that the B1 field 20 is as homogeneous as possible at the

20   location of the volume of interest 5 (see part 20b of the curve 20).

It is noted that in the example of the Figs. 1 and 2 two coils 11 and 12 are used for illustrating the principles of the present invention. However, the present invention is not restricted to the use of two coils; in fact, the number of coils may be any number larger than one, although in practice the number will not be very large.

25   It is further noted that in the above example only the effect of relative amplification/attenuation of the two coil signals is discussed. In practice it may also be appropriate to introduce a relative phase shift between the two coil signals in order to compensate for relative delays caused by differences in propagation velocity of the field in the object under observation.

30   Fig. 3 schematically illustrates an embodiment of a coil drive circuit 100 for implementing the above coil drive method in the MRI system 1. A signal generator 101 generates a basic signal S_B. If required, an amplifier 102 amplifies this basic signal S_B; such an amplifier may also be incorporated in the signal generator 101. Since such a signal generator for generating a basic nuclear magnetic resonance (NMR) drive signal is

6

commonly known and the present invention can be implemented using a prior art signal generator, it is not necessary here to discuss the design of such a generator in more detail. Moreover, since a suitable shape of a basic NMR drive signal is known to persons skilled in this art, it is not necessary either to discuss such a shape in more detail.

5   The coil drive circuit 100 comprises a plurality of coil drive branches 110, 120, etc for driving the plurality of coils 11, 12, etc. In this example only two coils 11 and 12 are discussed; therefore, only two corresponding branches 110, 120 are shown. Each coil drive branch 110, 120 comprises a series arrangement of a controllable amplifier/attenuator 111, 121 and a controllable phase shifter 112, 122, controlled by a controller 103 which has

10   an associated memory 104. In the example shown, the phase shifter is always arranged behind the amplifier, but this order may also be reversed.

Each branch 110, 120 has its input side (in this case the input of amplifier/attenuator 111, 121) coupled to the output of the generator amplifier 102. Each amplifier/attenuator 111, 121 amplifies or attenuates its input signal with a gain factor G1,

15   G2 under the control of the controller 103 so as to provide an amplified signal $S_{BA1} = G1 \cdot S_B$ and $S_{BA2} = G2 \cdot S_B$, respectively. Each phase shifter 112, 122 generates an output signal S_{D1} and S_{D2}, respectively, which is substantially identical to its input signal S_{BA1} and S_{BA2}, respectively, but delayed by a delay $\delta1$, $\delta2$ under the control of the controller 103. The output signals S_{D1} and S_{D2}, respectively, are applied to the coils 11 and 12, respectively. Thus, the

20   coils 11, 12 are driven by coil drive signals S_{D1}, S_{D2}, respectively, which can be written as:

$$S_{D1}(t+\delta1) = G1 \cdot S_B(t)$$

$$S_{D2}(t+\delta2) = G2 \cdot S_B(t)$$

wherein t represents time.

The controller 103 is designed to control the gain G1 and G2 applied by

25   amplifier/attenuator 111 and 121, respectively, and the phase shifts $\delta1$ and $\delta2$ applied by the phase shifter 112 and 122, respectively, in such a way that the coils 11, 12 receiving said output signals $S_{D1}(t+\delta1) = G1 \cdot S_B(t)$ and $S_{D2}(t+\delta2) = G2 \cdot S_B(t)$, respectively, generate magnetic field contributions 21, 22 such that the resultant overall magnetic field 20 is as homogeneous as possible in the volume of interest 5 (see 22b in Fig. 2). In order to enable the

30   controller 103 to do so, the memory 104 contains information on the field characteristics of each coil 11, 12 (curves 21, 22 in Fig. 1) as well as information on field distortions caused by the object 3 in the object space 2. The controller 103 also has a user input 105, allowing a user to input a selection of an object part 4 of the object 3. For instance, if the object 3 is a

human body, the user can for instance select the liver or the stomach or any other organ as object part of interest. Based on this input information, and on the information in the memory 104, the controller 103 sets the gains G1, G2 and the phase shifts $\delta1$, $\delta2$ such that the overall B1 field in the selected object part of interest is substantially homogeneous.

5   It is noted that the present invention does not necessarily aim to improve the homogeneity in the entire object space 2. Instead, the present invention aims to improve the homogeneity of the resultant overall B1 field in a volume of interest. To this end, the present invention provides an MRI system 1 which comprises a plurality of transmit coils 11, 12. Each coil receives a coil drive signal S_{D1}, S_{D2} from a coil drive branch 110, 120. According

10   to an important aspect of the present invention, each coil drive branch 110, 120 receives the same input signal from a signal generator 101, so that all coils 11, 12 receive electrical signal pulses having the same shape, be it that the electrical signal pulses from different coils may have a different amplitude and a different phase, controlled by a controller 103 on the basis of characteristic information in a memory 104 as well as user input information. The

15   controller is designed to set the respective amplitudes and phases in such a way that the resultant overall B1 field is as homogeneous as possible in the volume of interest.

          It is further noted that the "degree of success" of the control action by the controller 103 depends on circumstances. Generally speaking, the smaller the size of the volume of interest 5, the better the homogeneity of the B1 field will be. At any rate, the

20   present invention succeeds in providing a homogeneity better than if all coils were driven with the same amplitude and phase.

          It should be clear to a person skilled in the art that the present invention is not limited to the exemplary embodiments discussed above, but that various variations and modifications are possible within the protective scope of the invention as defined in the

25   appended claims. For instance, although the volume of interest in the Figs. 1 and 2 is shown as a 2D surface, the present invention is not restricted to 2D volumes; instead, the volume of interest may be a 1D volume or a 3D volume.

CLAIMS:

1.   A magnetic resonance imaging (MRI) system (1) comprising:

-       an object space (2) for receiving an object (3) to be examined;

-       a main magnet system for generating a main magnetic field in the object space;

5   -   a gradient magnet system for generating gradients of the main magnetic field in the object space;

-       a plurality of transmit coils (11, 12) located adjacent the object space (2);

-       a coil drive circuit (100) for generating a plurality of individual coil drive signals (S_{D1}, S_{D2}),

10 characterized in that the individual coil drive signals (S_{D1}, S_{D2}) are generated by the coil drive circuit (100) so as to have a substantially identical shape, the system (1) having controllable means (110, 120) for individually setting the amplitude and/or phase of each of said coil drive signals S_{D1}, S_{D2}), and a controller (103) for controlling said controllable means (110, 120).

15

2.   An MRI system (1) as claimed in claim 1, characterized in that said controller (103) has a user input (105) for receiving a user input signal defining or selecting a volume of interest (5) within said object space (2).

20 3.   An MRI system (1) as claimed in claim 1, characterized in that said coil drive circuit (100) comprises a signal generator (101) for generating a basic signal (S_B) and a plurality of coil drive branches (110, 120) for driving a respective one of the plurality of coils (11, 12), said drive branches being coupled to receive input signals derived from or identical to said basic signal (S_B).

25

4.   An MRI system as claimed in claim 3, characterized in that each coil drive branch (110, 120) has its input coupled to one output of said signal generator (101).

5.   An MRI system (1) as claimed in claim 3, characterized in that said coil drive circuit (100) also comprises a basic amplifier (102) having an input connected to an output of said signal generator (101), each coil drive branch (110, 120) having its input coupled to one output of said basic amplifier (102).

5

6.   An MRI system (1) as claimed in claim 3, characterized in that each coil drive branch (110, 120) comprises a controllable amplifier (111, 121).

7.   An MRI system (1) as claimed in claim 3, characterized in that each coil drive

10   branch (110, 120) comprises a controllable phase shifter (112, 122).

8.   An MRI system (1) as claimed in claim 6 or 7, characterized in that said controller (103) is coupled to control said controllable amplifier (111, 112) and/or said controllable phase shifter (112, 122).

15

9.   An MRI system (1) as claimed in claim 8, characterized in that the system also comprises a memory (104), associated with said controller (103), for storing information on the field characteristics of each coil (11, 12) and for storing information on field distortions caused by an object (3) in the object space (2).

20

10.   An MRI system as claimed in claim 9, characterized in that said controller (103) is designed to:
-       receive input information at an input (105), said input information relating to a type of object (3) in the object space (2) and a selection of an object part (4);

25 -   read from said memory (104) individual field characteristics (21, 22) of the individual transmit coils (11, 12) as well as field distortion characteristics of the object (3) in the object space (2);
-       control the settings of said controllable amplifier (111, 121) and/or the settings of said controllable phase shifter (112, 122), taking into account said information received at

30   said input (105) as well as said information read from said memory (104), in such a way that, an overall magnetic field of improved homogeneity, is obtained in a predetermined volume of interest (5) corresponding to said object part (4).

11.   An MRI system (1) as claimed in claim 10, characterized in that said
controller (103) is designed to control the settings of said controllable amplifier (111, 121)
and/or the settings of said controllable phase shifter (112, 122) in such a way that an overall
magnetic field has a locally substantially constant magnitude at a location within said volume
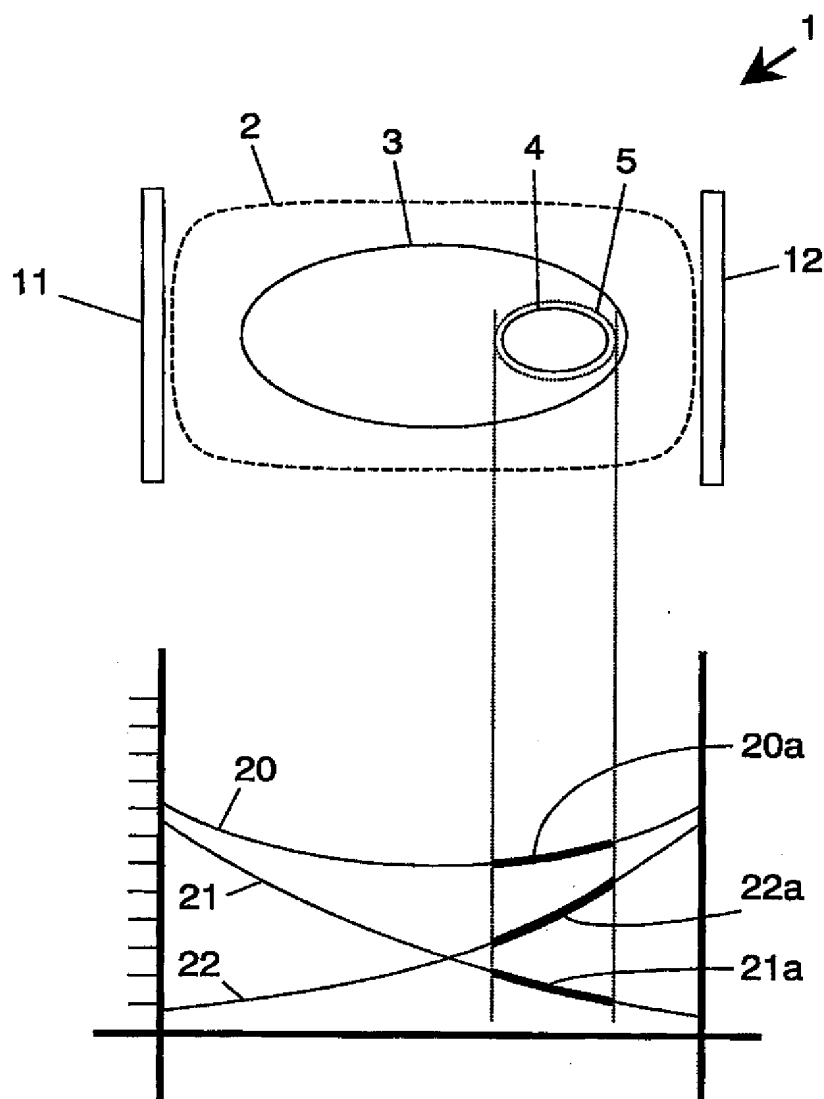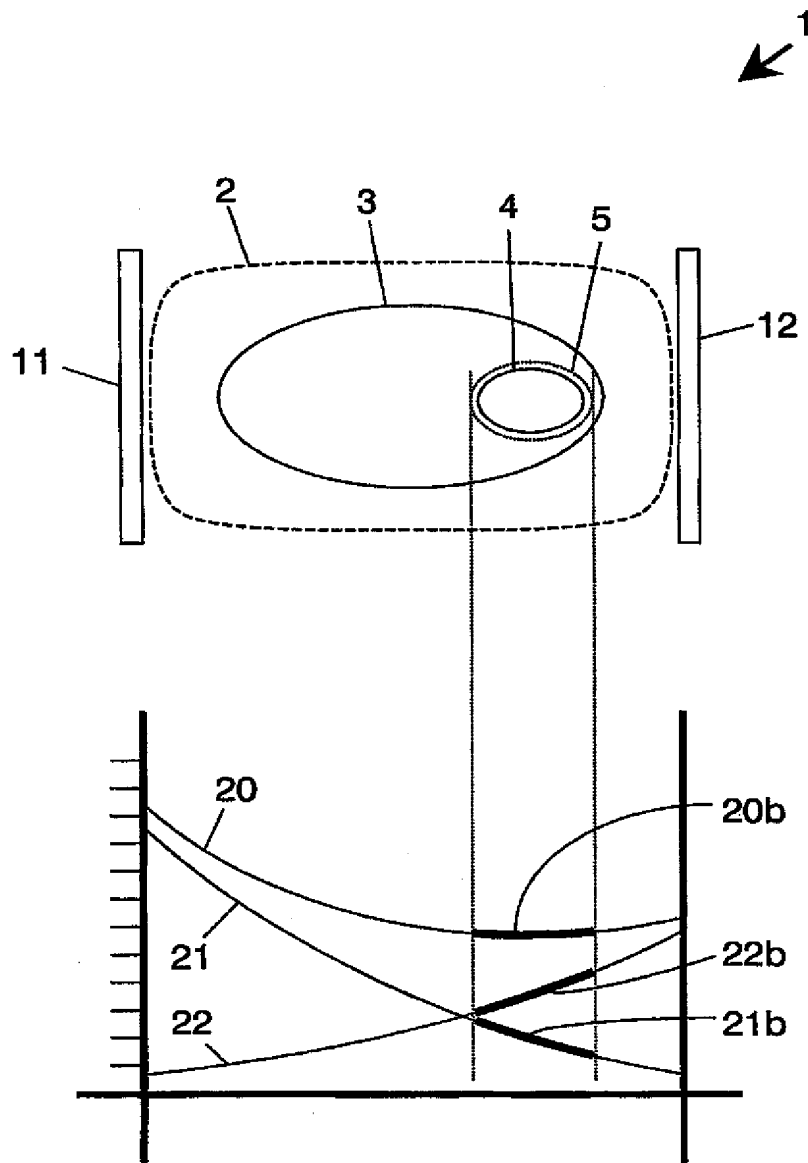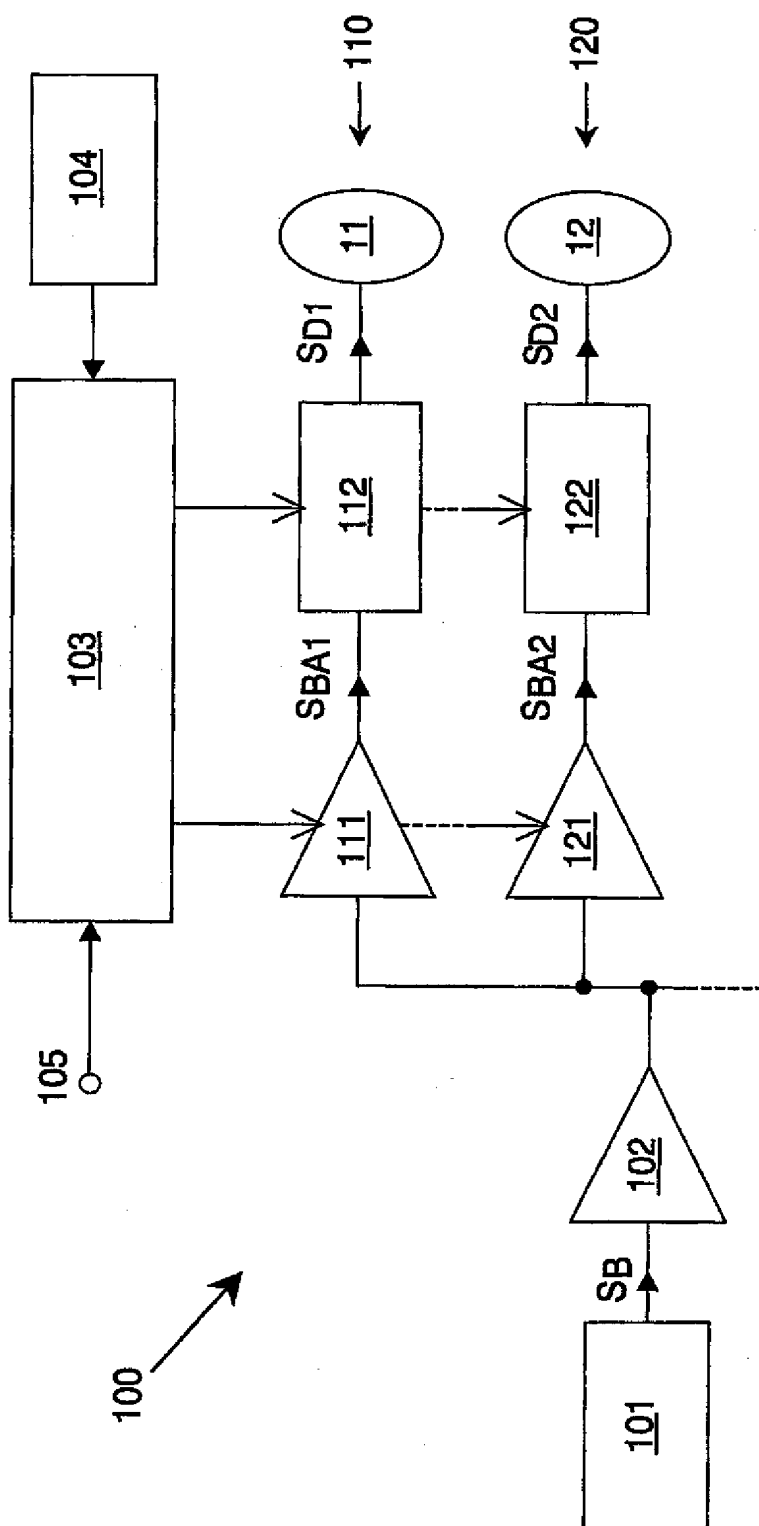5   of interest (5), preferably at the center of said volume of interest (5).

FIG.1

FIG.2

FIG.3